Formox and Formaldehyde market update – A turbo in the future?

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Introduction

Two years ago at the MMSA conference here in Singapore I presented a market update on formaldehyde and Formox view on the prospects for formaldehyde. Since then the “formaldehyde world” has changed a bit and the Formox world has changed a lot. Formaldehyde technology has also been a subject for revision and new innovations have made it possible to drastically reduce the power consumption in formaldehyde plants.

From day one (of the company) until 31st March this year Formox was a part of the Perstorp Group, but since 1st April JM Formox is a part of Johnson Matthey. This means I will have a lot more colleagues attending this conference. More importantly we are now a part of a company that are less focused on bulk chemical production and more on providing world class technologies and catalysts, which is of course a much more suitable home for us.

The formaldehyde market

At the last conference I walked you through the history of formaldehyde and anyone in the audience with good memory might remember that from 1900 to 1960 the world market grew from 0 to 3 mMTPA. From 1960 to 2000 its growth was far faster, growing from 3 to 19 mMTPA due to several factors such as more use of “man made” wood products, more plastics, more coatings etc., all using formaldehyde. However, from 2000 until today the market (usage) has grown from 19 mMTPA to more than 40 mMTPA with most of this expansion coming from new capacity in China. However, as yet there is only one Chinese producer among the top ten; a group that control 24% of the world market.

Fig 1. World installed formaldehyde capacity

<table>
<thead>
<tr>
<th>Region</th>
<th>1999 Capacity (kTPA)</th>
<th>1999 %</th>
<th>2012 Capacity (kTPA)</th>
<th>2012 %</th>
<th>Average volume added (kTPA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Africa</td>
<td>205</td>
<td>&lt;1</td>
<td>443</td>
<td>&lt;1</td>
<td>18</td>
</tr>
<tr>
<td>Asia</td>
<td>6,443</td>
<td>25</td>
<td>33,993</td>
<td>56</td>
<td>2119</td>
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<tr>
<td>Australasia</td>
<td>363</td>
<td>1</td>
<td>479</td>
<td>&lt;1</td>
<td>9</td>
</tr>
<tr>
<td>Europe</td>
<td>11,651</td>
<td>45</td>
<td>16,145</td>
<td>27</td>
<td>346</td>
</tr>
<tr>
<td>M. East</td>
<td>281</td>
<td>1</td>
<td>979</td>
<td>2</td>
<td>54</td>
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<tr>
<td>N. America</td>
<td>5,840</td>
<td>23</td>
<td>6,582</td>
<td>11</td>
<td>57</td>
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<td>Latin America</td>
<td>1,048</td>
<td>4</td>
<td>1,783</td>
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<tr>
<td></td>
<td>25,831</td>
<td></td>
<td>60,404</td>
<td></td>
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</tbody>
</table>
The formaldehyde markets

As mentioned above, the formaldehyde derivatives are many and varied; it is used
- to produce binders and overlays for wood based panels and related products such as laminate flooring and furniture;
- as an intermediate in the manufacture of plastics, coatings, textiles and herbicides and
- in a multitude of small volume outlets that can be difficult to track.

For convenience we classify these segments as “Wood”, “Chemical” and "Others".

Fig 2. Formaldehyde consumption 2000 to 2011 per segment

Over the years both the “wood” and “chemicals” segments have consumed about the same amount of formaldehyde, although the percentage has changed from time to time in response to the economic health of the product sector in question. For example, the relative importance of wood fell in 2008/09 due to the disproportionate impact of the recession on the building industry.

The future

The future for formaldehyde looks slightly different today than it did two years ago. The reason behind this is mainly the shale gas boom in the USA; for the first time in many years we are seeing a significant interest in new formaldehyde plants in North America. There are also projects in China where formaldehyde is used as an intermediate for producing fuels from coal. If or when such technology is commercialized, it might change the demand for formaldehyde dramatically. However, in the figures that you will see in the rest of this paper, we have not taken any formaldehyde to be used for fuel into consideration. Other than using formaldehyde as a fuel intermediate, not many new formaldehyde applications have
been launched recent years, so the growth we are expecting will come from traditional applications.

In general, we do not expect any change in the driving factors for formaldehyde demand growth in North America and Europe for the coming eight to ten years compared with the last ten years; plastics will continue to replace metals and “real” wood will be replaced by engineered wood and panels. In the rest of the world, new formaldehyde demand will be created as the demand for these same materials increases due to greater prosperity and a more consumption oriented lifestyle.

After 2020 the situation is likely to be change again due to a shrinking “labour reserve” (increasing wages) and an ageing population in China resulting in a slower economic growth in that region. Other regions might compensate for this to some extent, but is seems likely that we will see a slower growth in formaldehyde demand between 2020 and 2030.

But maturing economies and maturing products are not the only uncertainties within this market. Formaldehyde itself may become increasingly unacceptable and it has emerged as an emotive topic more than once over the last 40 years. This time around, however, the pressure has been more sustained. As a result it is likely that, at least for most of us, formaldehyde will be subject to increased scrutiny and control. Though this is unlikely to have any effect on the “chemical” sector where formaldehyde is an intermediate, it will, as has happened in the past, have a bearing on the way the wood sector develops. In particular formaldehyde’s role in the future wood market will depend on the resin industry’s ability to deliver adhesive systems that meet tighter emission standards. However, the effect may not be as pronounced as expected because most of the growth in the wood sector will occur in countries where formaldehyde is a much less emotive topic.

**JM Formox forecasts**

So, how to put a value on the future demand? By looking at predictions from down-stream users, the coming eight to ten years are expected to be “business as usual”. For the longer term, it is of course more difficult to predict. The data is still supporting an expanding market, but the growth rate is lower.

Whatever happens we can for expect more growth in developing areas, meaning the market will move East. China is expected to grow from slightly below 40% today to some 50% by 2020 and thereafter stabilize at that range due to the factors described earlier.
Given that the current installed capacity is around 60 m MTPA, then by rights no new formaldehyde plants would be built for some time. But, of course, formaldehyde is very much a local product; it depends on the local supply and demand situation so plants will be built in some areas and closed in others.

These are forecasts and as accurate as we can make them. I hope that I will be able to return in ten years or so to tell why the forecasts were so good or to explain what happened that made them too pessimistic. There is at least one existing application that can give a turbo effect to growth (formaldehyde is used as a fuel derivate) but this has not been taken into account in the graphs.
The existing turbo

Whilst we wait to see if the formaldehyde market becomes turbo charged by its use as a fuel derivative, I would now like to turn your attention to a real turbo; by that I mean the turbo charger already available within the complete FORMOX™ formaldehyde plant range. In order to further sharpen the competitive edge in FORMOX plant technology we have developed the turbo charger concept for formaldehyde plants. The aim has been to lower the usage of electricity per ton of formaldehyde produced and to increase plant capacity within the same plant size without increasing investment costs.

In theory this is very simple, we just let the hot gases leaving the catalytic incinerator (ECS – Emission Control System reactor) expand through a gas turbine. The compressor is on the same shaft, and this replaces the pressurization blower. In other words we are using the kinetic (pressure) energy rather than the thermal energy in the exhaust gas stream. The thermal energy can still be recovered in the traditional manner by means of the ECS steam generator. By doing this we are increasing the operating pressure. We can increase the mass flow through the plant without increasing the volume flow and are able to feed more kilogrammes per hour of methanol through the plant without increasing the size of pipes and vessels. This is illustrated in figure 5.

Fig 5. System description
So is it really that simple? Of course not. It took nearly seven years, thousands of engineering hours for both JM Formox and our equipment supplier MAN and extensive site testing to make the concept a practical reality. The concept was awarded with the Chemical Engineering and ChemInnovation’s “Innovative Energy use award” 2012.

A standard turbocharger is designed for higher temperatures, higher mass flowrates and much higher pressure ratios than are seen in FORMOX formaldehyde plants. So the first question was, can we use a standard unit? Fortunately the answer was yes, provided we could find solutions to the key challenges; how to start it, how to control it and how to
maintain stable operation (oxygen and pressure) – all within the constraints set by the JM Formox safety system. This was not easy, but our development team did a great job; eventually we had a design that was ready to be proven “live” in a formaldehyde plant.

One of our long term customers, Egger, was interested and agreed to implement the turbocharger in a new plant in Radauti, Romania. After some modifications to the original design, we can now say that it works and works well. The operation is smooth, the operators can easily start and stop the plant and make all the normal adjustments. At the end of the day it proved to be very little different from a conventional plant. So, what about the expected reduction in power consumption? It has also been confirmed, even at part load!

Fig 8. First installation (compressor to the left and turbine to the right)

Clearly a turbocharger is of considerable benefit. As we needed to minimize pressure losses (and preserve the pressure energy), many changes were required compared to the previous plant designs. However, assuming standard European power costs, 0.1 Euro/kWh for electricity, the payback will be one to two years (depending on the value of steam). So what does it do in terms of energy savings? Well, at the normal guarantee point it will save one third of the electrical energy used to operate the formaldehyde plant. In the future, when even higher pressures will be applied, it will save even more.

The use of a turbocharger will of course also be applicable for other chemical processes which are operated with overpressure, need a fresh air feed to the process and have a hot gas leaving the process.

Conclusion
What are the conclusions to be drawn from this paper? Is there a “turbo” in the future? For plants it is already here and it will help our customer to save significant energy costs. And for the market? JM Formox’s view is that we expect business as usual for the coming eight to ten years. After that it is more uncertain and will be strongly dependent on what happens as the Chinese economy becomes more mature. There are certainly opportunities for a “turbo” on the market as well if formaldehyde will be used as an intermediate for fuels. And JM Formox, as a part of Johnson Matthey, is very well positioned to meet the future demands from the market, both in terms of catalyst and plant supply.

Notes

Special thanks to Mr. Bob Crichton for his contribution to this paper.

MT = metric tons
MTPA = metric tons per annum
All measures are in 37wt% formaldehyde.
1000 kg of 37wt% formaldehyde consumes approximately 430 kg of methanol

FORMOX is a trademark of the Johnson Matthey group of companies.